

HREXI prototype for 4piXIO

Completed Technology Project (2017 - 2020)



Project Introduction

We propose to complete our development of the High Resolution Energetic X-ray Imager (HREXI) and to build and test a full Engineering Model of a detector and telescope system for a 12U Cubesat that will be proposed for a test flight. This will enable a future SMEX (or MIDEX) proposal for a 4piXIO mission: a constellation of Cubesats (or Smallsats) that would dramatically increase the sensitivity, source location precision and especially number of Gamma Ray Bursts (GRBs) to explore the Early Universe. Over the past two years of our current APRA grant, we have developed the world's first (to our knowledge) readout of a high-level imaging detector that is entirely three dimensional so that imaging detectors can then be tiled in close-packed arrays of arbitrary total area. This important new technology is achieved by replacing the external lateral readout of an ASIC, which reads out data from (for example) a 2 x 2 cm imaging detector through "wire bonds" to external circuits in the same plane but beyond the detector, with a vertical readout through the ASIC itself to external circuits directly below. This new technology greatly simplifies the assembly of the large area, tiled arrays of such detectors and their readout ASICs used for coded aperture wide-field telescopes that are uniquely able to discover and study X-ray (and low energy gamma-ray) transients and bursts that are key to understanding the physics and evolution of black holes. The first actual fabrication of such 3D-readout of close-tiled HREXI imaging detectors is underway and will be demonstrated in this third and final year of the current APRA grant. This proposal takes the HREXI detector concept a major step further. By incorporating this technology into the design and fabrication of a complete Engineering Model of a HREXI detector and coded aperture telescope that would fit, with comfortable margins, in a 12U Cubesat, it opens the way for a future low-cost constellation of ~25 such 12U Cubesats to achieve the first full-sky, full-time imaging survey for Gamma-ray Bursts (GRBs) and transients. The full-sky/time coverage immediately increases GRB detections by factors of 6, a significant increase in the search for GRBs from the Early Universe. The proposal will also extend the development of smaller pixel size for the required ASIC chips which will significantly improve angular resolution and make the low-cost Cubesat mission even more compelling. The science goals that a multi-satellite mission enabled by HREXI detectors for high resolution imaging over the full sky include using GRBs to trace star formation back to the very first (Pop III) stars and using flares from quasars to track the growth and evolution of supermassive black holes. Both are key NASA and PCOS science objectives. This is achieved by combining coordinated optical and IR data from a 4piXIO mission with LSST ground-based optical data as well as optical/IR spectra from a future optical-IR spectroscopy telescope in space, such as the proposed TSO probe-class mission.



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

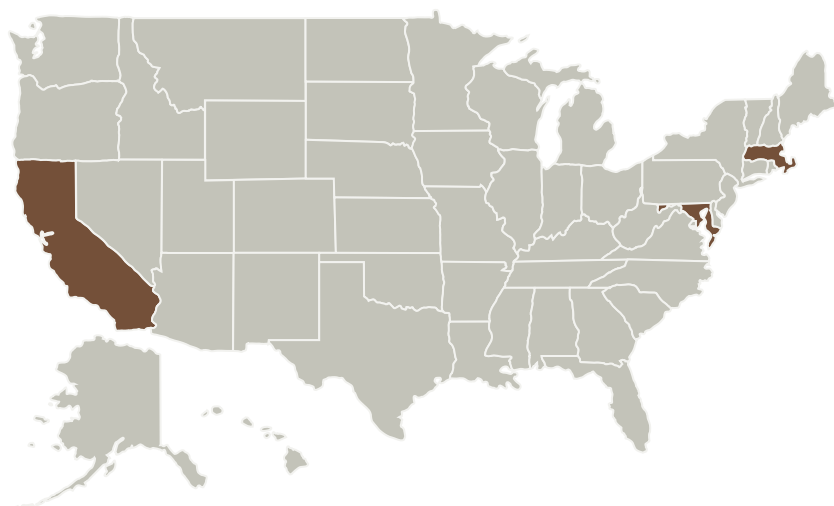
Harvard University

Responsible Program:

Astrophysics Research and Analysis



Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Harvard University	Lead Organization	Academia	Petersham, Massachusetts

Primary U.S. Work Locations	
California	Maryland
Massachusetts	

Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

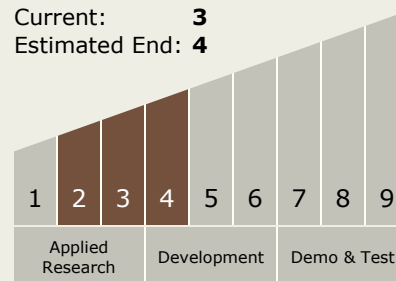
Jonathan E Grindlay

Co-Investigators:

Jaclyn Lucas
 Scott D Barthelmy
 Branden T Allen
 Jae Sub Hong
 Fiona A Harrison

Technology Maturity (TRL)

Start: 2
 Current: 3
 Estimated End: 4



Technology Areas

Primary:

- TX08 Sensors and Instruments
 - TX08.1 Remote Sensing Instruments/Sensors
 - TX08.1.1 Detectors and Focal Planes



Target Destination

Outside the Solar System